

National Climatic Data Center

DATA DOCUMENTATION

FOR

DATA SET 9816 (DSI-9816)

Canadian Monthly Precipitation

January 2, 2003

National Climatic Data Center
151 Patton Ave.
Asheville, NC 28801-5001 USA

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1. **Abstract:** The comprehensive data set of Canadian monthly meteorological information is available for the period from the beginning of observations (different for different stations, the earliest station starts in 1874) to year 1990. This data set was purchased from Canadian Atmospheric Environment Service (AES) by NCDC in the early 1990s and used in several climatological assessments. In those analyses we used subsets of these data (less than 1500 stations that met several requirements on the length of the time series, representativeness for selected regions and/or period of time). Now we present these data in their entirety (all available stations with adequate metadata that measured precipitation after 1891). Efforts were made to eliminate instrumental inhomogeneities that plague climatological analyses of Canadian precipitation.

Efforts were made to account for all stations with the following exceptions:

- Of the 9320 stations listed in the original station list, nine had the same coordinates as their neighbors and no any precipitation information. They were excluded from our master list.
- Of the 9311 remaining stations in the master list, 246 did not have coordinates (only station ID and name). For many of these stations we were able to estimate the coordinates (proxy) using the station name. For example, Hamilton, Ontario airport has more than 20 stations with unique ID# but only few of them have their coordinates listed. In these cases we selected coordinates that differ slightly (usually by 1' or 2' in a no particular order) and marked the coordinates of these stations as proxy values. Often these are old station sites, whose coordinates are not well known to the data compilers after the station relocation. We, however, prefer to keep these stations in the archive. There are 105 such sites with proxy coordinates. 140 stations with unique ID# and name but without coordinates were eliminated from the archive. This left us with 9171 stations in our master list.

Rainfall adjustments.

Several parameters have been retrieved from the original data set: mean monthly rainfall, snowfall, precipitation, and number of days with rain, N_{rain} .

The number of days with rain was used to correct rain gauge data to "ground truth" values. Recent findings by Metcalfe et al. (1997) and Mekis and Metcalfe (1997) indicate that for the period before 1975, Canadian rain gauges had wetting losses approximately 0.16 mm per measurement. Additionally, it was recommended to multiply the measured values of the rainfall by a factor 1.02 to account for wind-induced undercatch. Both these adjustments increase the original data by approximately 5% before 1975 and by 2% thereafter. We do not have information about the number of non-zero rainfall measurements per day at all of 6692 stations during the past century and hence use the following simplified monthly rainfall adjustments. (

For periods before 1975:

$$\begin{aligned} \text{Adjusted Rainfall (mm)} &= 1.02 \times [\text{Measured rainfall} + 0.2 \times (\text{Mean number of} \\ &\quad \text{days with rain})] \\ &= 0, \text{ if Measured rainfall is equal to zero.} \end{aligned}$$

Usually, the number of days with rain was not available (it was inserted into this archive only in the 1980s) and it was replaced by its mean monthly climatological values at the site or (if absent) interpolated from the nearby

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locations. 2172 stations have this information for at least five years. For other stations it was interpolated using the nearest neighbor method.

For period since 1975:

Adjusted Rainfall (mm) = 1.02 x [Measured rainfall]

Snowfall adjustments.

There are two instruments used in Canada for snowfall measurements. 85% of Canadian meteorological stations make snow ruler measurements of the depth of freshly fallen snow and then use a ten to one ratio to convert this depth into the snow water equivalent. Starting from the early 1960s some stations (mostly in the first-order network) were equipped with Nipher-shielded elevated snow gauge that directly measures water equivalent of snowfall but with a bias common to elevated gauges world-wide: they are prone to wind-induced error and undercatch precipitation. During the International Solid Precipitation Intercomparison Project this gauge was carefully investigated. Testing abroad reveals systematic undercatch of about 15%. This error is much smaller than for other national gauges. Canadian specialists, however, estimate that their gauge catches on average about 90% of ground true precipitation. While this may well be true, the errors will be site-specific.

An accurate adjustment for this undercatch requires wind and site exposure information that we do not have. Therefore, we:

- (a) avoid using this gauge directly for specific monthly frozen precipitation data; instead of it we use snow ruler data only as they provide homogenous time series; and
- (b) adjusted the scale of the snow ruler measurements using climatologically-derived relationships between the snow ruler and elevated snow gauge values. There are systematic differences between these two instruments but mean monthly totals derived from them are closely correlated ($r \sim 0.98$ or more).

To accomplish the second goal we have to:

- Identify the sites and periods where frozen precipitation is measured by the Nipher gauge;
- Calculate the mean monthly ratios of the two snowfall measurements (RAT). The difference between total precipitation and rainfall provides an estimate (biased) of the liquid water equivalent of snowfall (at the stations equipped with snow gauges, these differences provide the first estimate of the snowfall and the snow ruler measurements give the second one).
- Interpolate the ratios to each location thus deriving mean monthly adjustment factors that make snowfall measurements less biased and do not affect the homogeneity of their time series (We used Akima's (1978) method of bivariate interpolation from the nearest stations in 500 km radii);
- Increase these values by a factor of (1/0.9) to account for average snow gauge undercatch; and finally
- Increase/decrease each monthly snowfall value at each site by one of these constant factors, when the liquid water equivalent of the long-term mean snowfall (\bar{S}) was above 3 mm/month. Snowfall in intermediate months, when $\bar{S} < 3$ mm/month were not corrected.

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The adjusted liquid water equivalent of monthly total frozen precipitation (P_{frozen}) for each year and month is estimated as

$$P_{\text{frozen}} = \text{RAT} * S / 9,$$

where S is measured in cm and P_{frozen} in mm.

RAT is usually less than 1 (in cold climates of Northern Canada as low as 0.6) but in intermediate seasons in humid coastal areas this ratio can be as high as 1.1. Where mean monthly snowfall is less than 3 cm/month and/or for the stations/months where we were not able to estimate RAT-values*, were assumed a RAT value of 1.

The combination of monthly rainfall and snowfall $\times 0.1$ gives total precipitation value in the original Canadian archive unless a new Nipher shielded snow gauge has been introduced at the site. In the absence of the real metadata with appropriate information, we used a threshold, $TH = 0.1$, in

$$|(\text{Total Precipitation} - \text{Rainfall}) / (0.1 * \text{Snowfall}) - 1| \geq TH \quad [\text{or} \quad | (P - R) / 0.1S - 1| \geq TH].$$

* i.e., in the 500-km radius around a station we did not find even two nearest stations with valid RAT values due to the station paucity and/or the absence of valid RAT estimates.

From the date when this threshold was first reached (after year 1959) up to the last date when this threshold ratio deviated from 1 by at least 0.03 (this took care for common situation when the snow gauge was eliminated at the station), we calculated the average $\text{RAT} = (P - R) / 0.1S$. The situation when this ratio differs from 1 by more than 0.02 and the length of the sample used for its calculation is more than 7, was used as a preliminary indicator that the Nipher-shielded gauge was probably installed at the station. The use of this rule leaves us with 493 sites (676 if we would not consider the chance of the return to the ruler snow measurements) where there was a possible "gauge change". In fact some of these "changes" are simply data errors, which were revealed by our quality control. For example, at Saanich Dom Astro Observatory in British Columbia (ID#10169DK), January 1966 shows a large significant deviation from 1 in RAT values. This resulted in average $\text{RAT} = 1.15$ for the next 12 years, but in fact only one year, 1966, contributed to this deviation [$P = 173.5$ mm, $R = 126.5$ mm, $S = 265$ cm, $\Rightarrow \text{RAT} = 2.85$] while other 11 years in this month (and for all other months of the cold season) continue reporting $\text{RAT} = 1.0$. This is an obvious error revealed by our QC in the data and it should not affect our climatological estimates of mean monthly RAT. It is known that there are about 300 stations equipped with Nipher shielded snow gauges. Therefore, additional analysis of the ratios has been performed.

Sites where the threshold was exceeded only in one or two months of the cold season and/or standard deviation of individual RAT values was above 0.2 in these months were excluded. Individual mean monthly RAT values were considered valid if they are based on at least 5 years of data and the mean monthly snowfall in these years was above 3 cm. We took into account special situations, when there were errors in the data and/or snow gauges were removed

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and installed repeatedly (Table 2). This left us with 316 sites with possible gauge changes. After a visual control (Table 1) that mostly eliminated sites that are inconsistent with neighboring stations and among RAT values in months of the cold season, a set of 289 stations was selected where the gauge change was most probable and where our estimates of its differences were coherent. In the regions/months where snowfall does not occur the ratio is equal to one by definition. It is important to note that this selection was done in order to construct the most reliable climatological fields of RAT. Therefore, short samples and/or data errors that affect RAT estimates were eliminated without regret even when the site has a snow gauge installed. We do not plan to use these gauges in our final data set but use them here only for adjustment purposes: to get the best possible RAT values.

Table 1. Stations eliminated from the set of 316 stations for RAT calculations.

<u>St-n ID</u>	<u>Name</u>	<u>Province</u>	<u>Reasons for rejection</u>
2101100	Teslin	YT	After 1979, the station does not report RAT dif. from 1
2200900	Coppermine	NWT	After 1977 station does not report RAT different from 1 and contradicts data of nearby Coppermine, A.
2300700	Chesterfield	NWT	After 1976 station does not report RAT dif. from 1
2301100	Ennadai Lake	NWT	After 1972/76 stn does not report RAT dif. from 1
2502600	Isachsen	NWT	Small precipitation. No winter signal. After 1974 no information or RAT is ~ 1.
3016761	Vegreville	ALTA	RAT values contradict neighbors. Short sample. Data for RAT differ from 1 only before 1973.
3065305	Primrose	ALTA	Insufficient data for estimation.
4011160	Carlisle	SASK	Short time series of RAT in cold season
4016640	Regina	SASK	Contradiction with neighbors (Regina A)
4036844	Rockglen	SASK	Insufficient amount of data
4060981	Buffalo Narrows	SASK	Insufficient amount of data. No RAT different from 1 after 1977. Gauge installed, removed, and installed again.
4065055	Meadow Lake	SASK	Differs from neighbors (Meadow Lake A). No data on RAT after 1978.
5010485	Brandon CDA	MAN	Differs from neighbors (Brandon A). No RAT after 1982.
5021054	Glenlea	MAN	Error in February (value deleted). Short sample. After Feb. 1978 no RAT values different from 1.
5022125	Pilot Mound (aut)	MAN	Gauge installed, removed, and installed again; short sample; contradicts with neighboring stations
5031111	Grand Rapids hydro	MAN	Contradict to neighbor stations (Grand Rapids).
5063040	Wabowden	MAN	Short time series (after 1070 RAT
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6061358	Chapleau	ONT	=1) . Short time series. Contradicts with neighbors.
7013362	Jouliette Ville	QUE	Very short time series of RAT
7027040	Ste Clothilde CDA	QUE	Very short time series of RAT
7054095	La Pocatiere CDA	QUE	Very short time series of RAT (ends in 1973)
7103282	Inukjuak	QUE	Gauge installed, removed, and installed again.
7112400	Fort Chimo	QUE	Values contradict with those from neighboring stations. RAT discontinued in 1978.
8103050	Miscou Island (aut)	NB	Very short time series of RAT.
8201716	Eddy Point	NS	Very short time series of RAT.
8205126	Shelburne	NS	Short time series of RAT.
8206450	Wreck Cove Brook	NS	Very short time series of RAT.

Table 2. Special situations/processing of the station data for RAT calculations.

Stn ID	Name,	Province	Reasons for special situation
2202101	Fort Simpson A	NWT	Gauge installed, removed, and installed again.
2300500	Baker Lake	NWT	Gauge installed, removed, and installed again.
2301000	Coral Harbour	NWT	Gauge installed, removed, and installed again.
2400300	Alert	NWT	Gauge installed, removed, and installed again.
2400800	Clyde	NWT	Gauge installed, removed, and installed again.
2402350	Hall Lake	NWT	Gauge installed, removed, and installed again.
2503650	Sachs Harbour A	NWT	Gauge installed, removed, installed, and removed again.
3013961	Lloydminster A	ALTA	Delete values for February. Error in the original data.
5013117	Wasagaming	MAN	Gauge installed, removed, and installed again.
5021848	Morden	MAN	Gauge installed, removed, and installed again.
5062922	Thompson A	MAN	Gauge installed, removed, and installed again.
6016975	Red Lake A	ONT	Gauge installed, removed, and installed again.
6034075	Kenora A	ONT	Gauge installed, removed, and installed again.
6073960	Kapuskasing CDA	ONT	Gauge installed, removed, and installed again.
7052960	Grindstone Isl.	QUE	Gauge installed, removed, and installed again.
7095480	Nitchequon	QUE	Gauge installed, removed, and installed again.

Adjustments for traces

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While we recognize a need for the trace adjustments (especially in Canadian Arctic) where a significant part of liquid water precipitation equivalent (>10%) can be in the form of traces, the existing practice to report traces does not allow their introduction into the data. Figure 1 illustrates differences in how they were reported at the first order network in Canada during the 20th century. An attempt to use the reported traces and their treatment as non-zero amounts will definitely result in inhomogeneity of the precipitation time series. The researcher who desperately needs less biased values of Canadian precipitation may consider an introduction of an additional climatological constant value to each data value (specific for season and location). We preserved original trace flags in our adjusted monthly precipitation data.

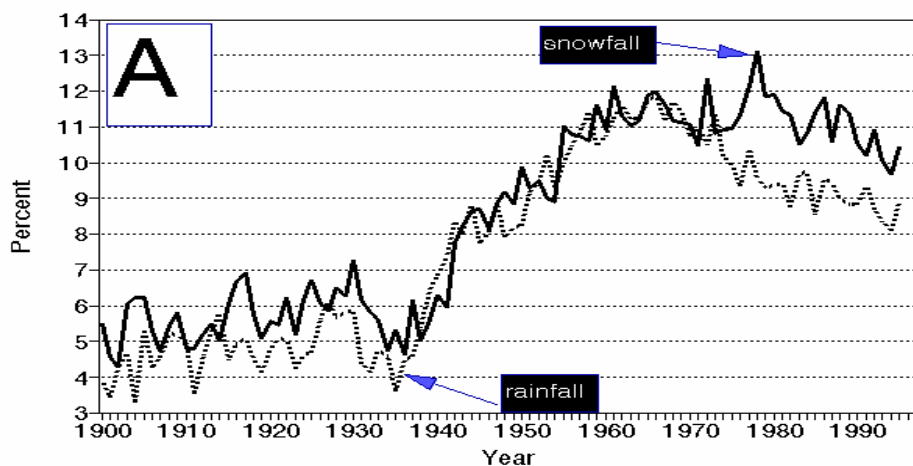


Figure 1. Changes with time in percent of days (per year) with reported trace precipitation at the Canadian First-Order stations for rainfall and snowfall separately. Average values for 95 Canadian stations of international exchange. The switch from the British to metric system in the early 1970s and a significantly higher diligence in trace reporting after the W.W.II prevented us from applying trace adjustments to the time series of instrumentally-homogeneous Canadian precipitation.

Final comments.

In the past few years, significant efforts have been made by the Canadian AES to further quality control their digital archives. It may well be that some problems that we have encountered with the present data set (purchased in early 1990s) have been already resolved. We, however, did not try to *correct* any of data values in the original files. Instead we only adjusted them (at the extent we could) to less-biased values that provide instrumentally homogeneous precipitation time series (rainfall, liquid water equivalent of frozen precipitation).

The original Canadian archive that NCDC purchased contains the data mostly up to 1990. Later we were able to receive updates of these data on a courtesy basis from Canadian AES but do not have rights to distribute them. Users interested in studying Canadian precipitation in the 1990s should contact AES directly to acquire the data.

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The following description of this archive may seem too extensive and the archive itself contains several intermediate data files that were used for adjustments. There is a good reason for this. The user who is not satisfied with any of the procedures used or who possess more elaborate information than we did can easily improve our estimates and advance in his/her understanding of precipitation changes over Canada. Below we list ways to improve our product:

An update. The 1990s are not covered by the present archive. While climate change studies will benefit from more recent data, additional data will significantly improve the accuracy of RAT and N_{rain} estimates used here for snowfall and rainfall adjustments. At some sites we were not able to get stable estimates of these characteristics and had to discard them due to short sample size and/or high variance of the estimates (sometimes due to obvious errors in original data).

Additional metadata.

1) As a last resort, we used the data themselves to retrieve the information about the period of snow gauge installation. We realize that this method is prone to errors due to random errors in precipitation, rainfall, snowfall data and could miss the date of the gauge installation in the months when RAT is naturally close to 1. Therefore, a conservative approach was used in our RAT estimation and we discard many values that potentially could be useful. The user who has definite information about the period of snow gauge installation at Canadian stations can produce much better RAT-estimates even without laborious analyses of the RAT- time series.

2) Sometimes even basic metadata (coordinates and site elevation) were incomplete. We were forced to discard several stations without coordinate information, use proxy coordinates for some others, and mark elevation as missing at more than hundred sites.

3). Lacking wind data and descriptions of instrument exposure at the stations, we were not able to account accurately for wind-induced biases in Nipher-shielded Canadian snow gauge measurements. A scalar factor of 0.9 used throughout the entire country is a gross approximation of the average snow gauge catch. The user who has a better knowledge of the wind regime and site exposure at some of the 289 stations where our RAT-estimates are available, can significantly improve the scale of our time series of liquid water equivalent of snowfall around these stations and make them less biased.

The use of daily precipitation data for adjustments. Canadian specialists argue that a much better adjusted monthly precipitation product can be generated using daily records and an entire set of supplementary information (including wind over the gauge orifice, traces, and the number of non-zero precipitation measurements per month). This is true and we would like to add to this list the metadata mentioned above. However, most users (us included) do not have an access to this supplementary information. Some of it is absent entirely (e.g., wind speed, exposure description of the past instrument locations) or is of questionable quality (trace reports, cf. Figure 1). In the future, we plan to check the potential level of adjustment improvement that can be achieved using daily data from a selected subset of the best Canadian first order stations (Figure 1 was generated from this subset).

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2. Element Names and Definitions:

(canad2nn.stn)

ID 7-character station ID according Canadian AES classification (unrelated to the WMO coding; a combination of numbers and letters should be expected in this ID);

NAME is the station name, coordinates, and elevation

STN_NAME	is the station name
LAT1	degrees of the station latitude (°N);
LAT2	minutes of the station latitude (°N);
LON1	degrees of the station longitude (°W);
LON2	minutes of the station longitude (°W);
STN_ELEV	is station elevation in feet;
COMMENT	can include additional information about the station name (in few cases we did not find this name/coordinates but assigned them PROXY values). In these cases COMMENT = 'PRO'.

(nrainse1.out)

ID 7-character station ID according Canadian AES classification (unrelated to the WMO coding; a combination of numbers and letters should be expected in this ID);

NAME is the station name, coordinates, and elevation

STN_NAME	is the station name
LAT1	degrees of the station latitude (°N);
LAT2	minutes of the station latitude (°N);
LON1	degrees of the station longitude (°W);
LON2	minutes of the station longitude (°W);
STN_ELEV	is station elevation in feet;

NP is the number of years with valid December precipitation records

NR is the same as NP but for rainfall records,

NS is the same as NP but for snowfall records, and

ND is the same as NP but for records with the number of days with rain and drizzle in June

RAIN_DAY 12 mean monthly values of number of days with rainfall and drizzle

(nrain.int)

ID 7-character station ID according Canadian AES classification (unrelated to the WMO coding; a combination of numbers and letters should be expected in this ID);

NAME is the station name, coordinates, and elevation

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STN_NAME is the station name
LAT1 degrees of the station latitude (°N);
LAT2 minutes of the station latitude (°N);
LON1 degrees of the station longitude (°W);
LON2 minutes of the station longitude (°W);
STN_ELEV is station elevation in feet;

NDATA1 is the number of stations in the 1000-km vicinity of the station

NDATA is the same as NDATA1 but the actual number of stations where December non-missing values were available.

(can_norm.out)

ID 7-character station ID according Canadian AES classification (unrelated to the WMO coding; a combination of numbers and letters should be expected in this ID);

NAME is the station name, coordinates, and elevation

STN_NAME is the station name
LAT1 degrees of the station latitude (°N);
LAT2 minutes of the station latitude (°N);
LON1 degrees of the station longitude (°W);
LON2 minutes of the station longitude (°W);
STN_ELEV is station elevation in feet

NP is the number of years with valid December precipitation records

NR is the same as NP but for rainfall records, and

NS is the same as NP but for snowfall records.

MEAN_PR 12 mean monthly values of precipitation

MEAN_RN 12 mean monthly values of rainfall

MEAN_SN 12 mean monthly values of snowfall

(canad2sl.out)

ID 7-character station ID according Canadian AES classification (unrelated to the WMO coding; a combination of numbers and letters should be expected in this ID);

NAME is the station name, coordinates, and elevation

STN_NAME is the station name
LAT1 degrees of the station latitude (°N);
LAT2 minutes of the station latitude (°N);

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LON1 degrees of the station longitude (°W);
LON2 minutes of the station longitude (°W);
STN_ELEV is station elevation in feet;

NGAUGE and MON are the year and the month, when we first found a
 significant deviation of RAT value from 1. This date was
 used as a most probable date of the Nipher-shielded snow
 gauge installation at the station.

RAT 12 mean monthly values of RAT-values

RAT_STD 12 mean monthly values of RAT-value standard deviations

PCP 12 mean monthly values of precipitation for the period when the
 Nipher-shielded snow gauge was most likely to be operational

SNOW 12 mean monthly values of snowfall for the period when most
 probably Nipher-shielded snow gauge was operational at this
 station

N_SAMPLE 12 monthly sample sizes used for RAT, PCP, and SNOW estimates

N_END the last year, when the monthly RAT-value significantly differ
 from 1 (i.e., most probable date, when the Nipher-shielded gauge
 was removed from the station or does not affect the 10:1 ratio of
 snow ruler/gauge measurements).

file "ratio.int" of mean monthly RAT values

ID 7-character station ID according Canadian AES classification (unrelated to the WMO coding; a combination of numbers and letters should be expected in this ID);

NAME is the station name, coordinates, and elevation

STN_NAME is the station name
LAT1 degrees of the station latitude (°N);
LAT2 minutes of the station latitude (°N);
LON1 degrees of the station longitude (°W);
LON2 minutes of the station longitude (°W);
STN_ELEV is station elevation in feet;

NDATA1 is the number of stations in the 500-km vicinity of the station

NDATA is the same as NDATA1 but the actual number of stations where
 December non-missing
 values were available.

RATINT 12 mean monthly values of interpolated RAT- values

(output files **CDN_MON.PCP**, **CDN_MON.RAI**, and **CDN_MON.SNO**)

ID 7-character station ID according Canadian AES classification (unrelated to the WMO coding; a combination of numbers and letters should be expected in this ID);

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ADJ_FLG can be 'O' indicating the original precipitation/rainfall/snowfall values or
'A' indicating that the data have been adjusted according to the above procedure;

LAT is the station latitude (°N) with two decimal points;

LON is the station longitude (°W) with two decimal points;

ELEV is the station elevation in tenths of meters (*Bene!*) with a missing value of -9999;

YEAR is the year of the observations minus 1000;

Array P(12) contains 12 monthly totals of precipitation (rainfall, liquid water equivalent of snowfall) in tenths of mm (missing values are coded "-1"; and

Array DAT_FLG(12) contains the data flags from the original AES archive. This flag can have four values:

blank (' ') valid value (no any comments);
M missing value;
T precipitation trace/traces were reported during the month;
E original value in archive has been estimated.

3. **Start Date:** 18749999 (varies by individual station)

4. **Stop Date:** 19909999 (varies by individual station)

5. **Coverage:** North America

- a. Southernmost Latitude: 41N
- b. Northernmost Latitude: 84N
- c. Westernmost Longitude: 141W
- d. Easternmost Longitude: 52W

6. **How to Order Data:**

Ask NCDC's Climate Services about the cost of obtaining this data set.
Phone: 828-271-4800
FAX: 828-271-4876
E-mail: NCDC.Orders@noaa.gov

7. **Archiving Data Center:**

National Climatic Data Center
Federal Building
151 Patton Avenue
Asheville, NC 28801-5001
Phone: (828) 271-4800.

8. **Technical Contact:**

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National Climatic Data Center
Federal Building
151 Patton Avenue
Asheville, NC 28801-5001
Phone: (828) 271-4800.

9. Known Uncorrected Problems: None.

10. Quality Statement: When the entire data set had been analyzed, we found that only 6708 of the stations have monthly precipitation data during the period 1891 to 1990. Additionally, 16 stations, which have precipitation data, do not have any name and coordinate information. We had to exclude these data from further consideration. This left only 6692 ID# entries in the final station list provided in file "canad2nn.stn". Only 10 stations with proxy coordinates remain in this list.

The original station list also contains 38 sites that do not belong to Canada (e.g., Penn. State meteorological data). These sites were also eliminated.

101 stations from the 6692 still do not have information about the site elevation. These values were left blank in the file "canad2nn.stn".

A significant number of stations report only one type of precipitation (rainfall or snowfall). From 6692 stations with the data, only 5187 have both rainfall and snowfall. For example, some automatic and/or auxiliary stations do not report rainfall and snowfall but only precipitation values. Quality control performed by the Canadian AES could also discard rainfall/snowfall values making impossible a restoration of adjusted monthly precipitation value. Therefore, it may be that the original archive has precipitation (rainfall/snowfall) data but the adjusted values are unavailable and vice versa.

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11. Essential Companion Datasets: No information provided with original documentation.

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:
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Appendix A: The Output Data files and their description.

1. The list of 6692 stations with precipitation data is stored in the file canad2nn.stn.

The file can be read with the following FORTRAN statement:

```
CHARACTER*7 ID
CHARACTER*45 NAME
READ (11,'(a7,a45)') ID, NAME
```

ID is the station ID number, a 7-character station ID according to Canadian AES classification (unrelated to the WMO coding). A combination of numbers and letters should be expected in this ID.

NAME is the station name, coordinates, and elevation. In turn, the line of characters NAME can be read with the following FORTRAN READ statement:

```
REAL LAT1, LAT2, LON1, LON2
CHARACTER STN_NAME, STN_ELEV, COMMENT
READ (      NAME(1:45), '(A28, F2.0, F2.0, F3.0, F2.0, A4, 1X, A3)')
      * STN_NAME, LAT1, LAT2, LON1, LON2, STN_ELEV, COMMENT
```

STN_NAME is the station name

LAT1 and LAT2 are the station latitude (°N in degrees and minutes);

LON1 and LON2 are the station longitude (°W in degrees and minutes);

STN_ELEV is station elevation in feet (*Bene!!!*);

COMMENT sometimes includes additional information about the station name (in few cases we did not find this name/coordinates but assigned them PROXY values). In these cases COMMENT = 'PRO'.

The first several lines of this file are given below:

```
1010066ACTIVE PASS          BC  4852123170013
1010235ALBERT HEAD         BC  4824123290056
1010595BAMBERTON OCEAN CEMENT BC  4835123310280
1010720BEAR CREEK          BC  4830124001150
1010774BEAVER LAKE         BC  4830123210200
```

..... *

2. The file "nrainsel.out" contains estimates of the mean monthly number of days with rainfall (N_{rain}) for 2172 Canadian stations. Some of these stations have insufficient data. These are marked as missing (Missing code is -1).

The file was written with the following FORTRAN statements:

First line:

```
WRITE (11,'(a7, 1x, a45, 4i3)') ID, NAME, NP, NR, NS, ND
```

Where,

ID is the station ID number,

NAME is the station name, coordinates, and elevation (identical to those in item 1)

NP is the number of years with valid December precipitation records

NR is the same as NP but for rainfall records,

:
:
:

NS is the same as NP but for snowfall records, and
 ND is the same as NP but for records with the number of days with rain and
 drizzle in June

Second line:

WRITE (11, '(12f6.1)') RAIN_DAY

Where 12 mean monthly values of number of days with rainfall and drizzle are
 stored in array RAIN_DAY(12).

The first several lines of this file are given below:

```
1011467 CENTRAL SAANICH VEYANESSBC 4835123250175      21 21 21  8
      20.0 16.6 15.5 15.2 12.0  8.4  5.1  4.0  5.8 13.4 -1.0 15.3
10114F6 CENTRAL SAANICH ISL VIEWBC 4834123220125      20 20 20  6
      15.2 15.5 15.0 13.6 12.2  6.0  5.3  4.0  6.8  8.6 18.6 13.9
1011810 COLWOOD HATLEY DR          BC 4825123290248      9  9  9  7
      19.6 17.8 16.9 13.2 10.7  6.7  4.9  3.6  6.0 12.8 19.7 15.1
1011922 CORDOVA BAY SOUTH          BC 4831123220085      14 14 14  7
      -1.0 -1.0 16.2 14.8 15.0  8.9  6.0  4.1  7.6 13.5 21.1 14.4
1012010 COWICHAN BAY CHERRY PT    BC 4843123330003      67 67 67  5
      17.4 -1.0 20.2 -1.0 12.6 11.8 -1.0 -1.0 -1.0 -1.0 -1.0 17.4
1012040 COWICHAN LAKE FORESTRY    BC 4850124080580      41 41 41  7
      17.5 15.0 20.7 15.4 13.4 10.4  7.5  5.3  8.9 14.8 -1.0 15.6
.....
```

3. The file "nrain.int" contains estimates of the mean monthly number of days
 with rainfall (N_{rain}) for all 6692 Canadian stations with precipitation. The
 values that were originally marked as missing in the file "nrainsel.out" have
 been filled by interpolation from the nearest station with a non-missing N_{rain} -
 value.

The file was written with the following FORTRAN statements:

First line:

WRITE (11, '(a7, 1x, a45, 2i5)') ID, NAME, NDATA1, NDATA

Where,

ID is the station ID number,
 NAME is the station name, coordinates, and elevation (identical to item
 1)
 NDATA1 is the number of stations in the 1000-km vicinity of the station
 NDATA is the same as NDATA1 but the actual number of stations where
 December non-missing values were available.

Second line:

REAL NRRAIN_INT(12)

WRITE (11, '(12f6.1)') NRRAIN.INT

Where 12 mean monthly values of interpolated N_{rain} - values are stored in array
 NRRAIN_INT(12).

The first several lines of this file are given below:

```
1010066 ACTIVE PASS          BC 4852123170013      690 580
      19.0 19.0 20.2 13.9 14.5  9.7  5.7  4.0  7.2 11.6 19.0 16.5
1010235 ALBERT HEAD         BC 4824123290056      661 563
:
:
:
18:
```

19.6	17.8	16.9	13.2	10.7	6.7	4.9	3.6	6.0	12.8	19.7	15.1
1010595	BAMBERTON OCEAN CEMENT	BC	4835123310280					668	567		
20.0	17.6	16.7	13.9	11.3	8.4	5.1	4.5	6.7	12.4	19.0	15.0
1010720	BEAR CREEK	BC	4830124001150					645	549		
19.6	16.7	17.7	14.0	13.0	9.0	5.6	4.5	8.3	14.8	20.6	16.5
1010774	BEAVER LAKE	BC	4830123210200					675	574		
17.7	15.5	16.2	14.8	15.0	8.9	6.0	4.1	7.6	13.5	21.1	14.4
1010780	BECHER BAY	BC	4820123380040					647	553		
18.3	14.4	18.0	15.0	12.6	8.3	5.0	3.2	6.3	14.9	20.2	15.7

.....

4. The file "can_norm.out" contains long-term mean monthly precipitation (mm), rainfall (mm), and snowfall (cm) values based on the entire period of observations at 6692 stations. This "entire period" can be 100 years but it can be also zero in some months. In these cases the mean monthly value was given the missing code "-1". The station "ID" line contains the number of years for time averaging for December (the number of years with precipitation, rainfall, and snowfall records respectively).

The file was written with the following FORTRAN statements:

First line:

WRITE(11, '(a7, 1x, a45, 3i5)') ID, NAME, NP, NR, NS

Where,

ID is the station ID number,

NAME is the station name, coordinates, and elevation (identical to item 1)

NP is the number of years with valid December precipitation records

NR is the same as NP but for rainfall records, and

NS is the same as NP but for snowfall records.

Second through fourth lines:

WRITE (11, '(12f6.1)') MEAN_PR, MEAN_RN, MEAN_SN

Where 12 mean monthly values of precipitation, rainfall, and snowfall are stored in arrays

MEAN_PR(12), MEAN_RN(12), and MEAN_SN(12) respectively.

The first several lines of this file are given below:

1010066	ACTIVE PASS	BC	4852123170013					4	4	4	
75.2	111.4	80.3	50.0	58.3	22.8	11.7	9.5	19.3	58.5	132.7	106.4
75.2	73.0	80.3	50.0	58.3	22.8	11.7	9.5	19.3	58.5	132.7	99.7
.0	38.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	6.7
1010235	ALBERT HEAD	BC	4824123290056					7	7	7	
176.8	120.8	87.3	36.9	25.1	16.6	17.2	31.8	31.4	85.5	149.4	198.3
168.2	117.9	86.8	36.9	25.1	16.6	17.2	31.8	31.4	85.5	145.7	190.2
8.6	2.9	.5	.0	.0	.0	.0	.0	.0	.0	3.7	8.0
1010595	BAMBERTON OCEAN CEMENT	BC	4835123310280					19	19	19	
194.7	125.7	104.6	52.7	35.1	28.5	19.3	26.0	42.7	103.7	163.4	219.1
172.6	122.0	100.4	52.7	35.1	28.5	19.3	26.0	42.7	103.7	161.3	200.0
22.2	3.6	4.2	.0	.0	.0	.0	.0	.0	.0	2.1	19.1
1010720	BEAR CREEK	BC	4830124001150					61	61	61	
466.4	366.7	306.2	201.6	101.4	72.3	46.5	61.4	155.0	358.2	420.3	528.8
385.2	320.3	257.8	193.3	101.2	72.3	46.5	61.4	155.0	357.8	408.1	480.5
81.3	46.3	48.3	8.4	.2	.0	.0	.0	.0	.4	12.2	48.4

:

5. The file "canad2sl.out" contains mean monthly number of RAT-values for 289 Canadian stations. Some of these stations have insufficient data. These are marked as missing (Missing code is -1). A description of LAT values is given in the Summary section.

The file was written with the following FORTRAN statements:

First line:

```
WRITE (11, '(a7, 1x, a45, 2i5)') ID, NAME, NGAUGE, MON
```

Where,

ID is the station ID number,
NAME is the station name, coordinates, and elevation (identical to those in item 1)
NGAUGE and MON are the year and the month, when we first found a significant deviation of RAT value from 1. This date was used as a most probable date of the Nipher-shielded snow gauge installation at the station.

Second and third lines:

```
WRITE (11, '(12F6.2)') RAT, RAT_STD
```

provide 12 mean monthly values of RAT and their standard deviations stored in arrays RAT(12) and RAT_STD(12) respectively.

Forth and fifth lines:

```
WRITE (11, '(12F6.1)') PCP, SNOW
```

provide 12 mean monthly values of precipitation and snowfall for the period when the Nipher-shielded snow gauge was most likely to be operational. These values are stored in arrays PCP(12) and SNOW(12) respectively.

Sixth and seventh lines:

```
WRITE (11, '(12I6)') N_SAMPLE, N_END
```

provide 12 monthly sample sizes used for RAT, PCP, and SNOW estimates and the last year when the monthly RAT-value significantly differs from 1 (i.e., most probable date, when the Nipher-shielded gauge was removed from the station or does not affect the 10:1 ratio of snow ruler/gauge measurements). Data are stored in arrays N_SAMPLE(12), and N_END(12) respectively.

The first several lines of this file are given below:

```
1018610 VICTORIA GONZALES HTS BC 4825123190228 1963 1
.96 1.09 -1.00 -1.00 -1.00 -1.00 -1.00 -1.00 -1.00 -1.00 -1.00 .98
.15 .17 .11 .17 -1.00 -1.00 -1.00 -1.00 -1.00 -1.00 .23 .20
105.8 76.5 52.4 30.9 24.0 21.3 12.6 18.2 34.5 67.1 103.4 118.0
12.1 6.9 2.6 .2 .0 .0 .0 .0 .0 .0 2.0 5.9
16 6 8 4 0 0 0 0 0 0 23 21
1978 1981 1974 1967 0 0 0 0 0 0 1985 1984
1018620 VICTORIA INT'L A BC 4839123260066 1965 1
1.05 1.10 1.01 -1.00 -1.00 -1.00 -1.00 -1.00 -1.00 -1.00 1.01 .96
.26 .20 .07 .00 -1.00 -1.00 -1.00 -1.00 -1.00 -1.00 .19 .09
138.9 101.5 72.1 42.5 32.7 29.7 17.6 23.7 36.5 79.1 132.0 145.9
18.2 8.8 4.1 .2 .0 .0 .0 .0 .0 .0 3.2 11.1
```

:
:
:

20	7	24	1	0	0	0	0	0	0	25	5
1984	1986	1989	1975	0	0	0	0	0	0	1985	1985

Typical values for Northern Canada in this file:

```

2500600 CAMBRIDGE BAY A          NWT 6906105070074      1964 1
.85 .84 .80 .83 .85 .92 -1.00 -1.00 .88 .87 .79 .77
.15 .18 .20 .18 .14 .17 .00 .21 .15 .12 .15 .18
5.3 4.3 5.1 6.2 8.9 12.9 23.3 26.7 18.2 14.3 8.4 5.2
5.8 4.9 5.8 6.9 8.8 4.6 .1 .7 8.1 14.7 9.4 5.9
27 27 27 26 28 30 1 17 26 26 26 25
1990 1990 1990 1989 1990 1990 1964 1979 1989 1989 1988 1988
2502700 MOULD BAY A          NWT 7614119200050      1970 1
.77 .84 .73 .76 .76 .91 1.07 .98 .84 .79 .90 .90
.18 .27 .21 .23 .44 .21 .40 .17 .14 .18 .39 .39
3.2 3.4 2.6 4.5 6.8 6.6 15.3 21.3 15.0 10.0 4.1 3.9
3.7 4.0 3.2 5.6 8.5 4.0 3.1 9.6 14.8 12.1 5.1 4.6
21 23 24 26 24 25 27 23 26 24 25 25
1990 1989 1990 1990 1990 1988 1986 1988 1989 1988 1988 1989

```

6. The file "ratio.int" contains mean monthly RAT values for all 6692 Canadian stations with precipitation. Most values that were marked as missing (Missing code is "-1") have been filled in by the Akima interpolation method (from the stations with a non-missing RAT-values from a 500 km vicinity of the station (if there were more than three stations with valid RAT values in this vicinity; when only two or three stations were found in this vicinity, the RAT value from a closest site was selected). When there are less than two such stations (e.g., in summer when snowfall is zero) missing codes replace the interpolated RAT value. This approach creates some biases in RAT values in the intermediate months at the stations, where snowfall is not usually recorded but is still observed 500 km North of the site (or in the mountains). This was taken into account during the precipitation adjustment procedure.

The file was written with the following FORTRAN statements:

First line:

```
WRITE (11, '(a7, 1x, a45, 2i5)') ID, NAME, NDATA1, NDATA
```

Where,

ID is the station ID number,
NAME is the station name and coordinates (identical to item 1)
NDATA1 is the number of stations in the 500-km vicinity of the station
NDATA is the same as NDATA1 but the actual number of stations where December non-missing values were available.

Second line:

```
WRITE (11, '(12f6.2)') RATINT
```

Where 12 mean monthly values of interpolated RAT- values are stored in array RATINT(12)

The first several lines of this file are given below:

```

:
:
:
21:

```

```

1010066 ACTIVE PASS          BC 4852123170013      15 15
  1.03 1.05 .98 .93 -1.00 -1.00 -1.00 -1.00 -1.00 .99 1.00 .93
1010235 ALBERT HEAD         BC 4824123290056      13 13
  .99 1.11 1.03 .95 -1.00 -1.00 -1.00 -1.00 -1.00 .98 1.01 .99
1010595 BAMBERTON OCEAN CEMENT BC 4835123310280      15 15
  1.02 1.11 1.02 .93 -1.00 -1.00 -1.00 -1.00 -1.00 1.00 1.02 .98
1010720 BEAR CREEK          BC 4830124001150      13 13
  1.08 1.17 1.05 .95 -1.00 -1.00 -1.00 -1.00 -1.00 .98 1.05 1.02
1010774 BEAVER LAKE         BC 4830123210200      14 14
  .99 1.09 1.02 .92 -1.00 -1.00 -1.00 -1.00 -1.00 1.01 1.00 .97
1010780 BECHER BAY          BC 4820123380040      13 13
  1.00 1.14 1.04 .95 -1.00 -1.00 -1.00 -1.00 -1.00 .98 1.02 1.01
1010960 BRENTWOOD BAY 2     BC 4836123280125      15 15
  1.05 1.11 1.02 .93 -1.00 -1.00 -1.00 -1.00 -1.00 1.00 1.01 .97
.....

```

7. The major output files **CDN_MON.PCP**, **CDN_MON.RAI**, and **CDN_MON.SNO** are constructed from original and adjusted precipitation, rainfall, and snowfall data respectively. They all have the same structure and incorporate (in addition to the station ID), coordinates, elevation, data flags (preserved from the original archive) and a special flag (original/adjusted) that allows user various data sorting/selection.

The files have been created with the following FORTRAN write statement:

```

CHARACTER*7 ID
CHARACTER*1 ADJ_FLG, DAT_FLG(12)
REAL LAT, LON
INTEGER YEAR, ELEV, P(12)
WRITE (10, '(A7, 1X, A1, 1X, F5.2, 1X, F6.2, 1X, I5, 1X, I3, 1X, 12(I5,
A1))')
  * ID, ADJ_FLG, LAT, LON, ELEV, YEAR, (P(J), DAT_FLG(J), J=1,12)

```

Where,

```

ID          is the station ID according the Canadian AES classification,
ADJ_FLG     can be
              'O' indicating the original precipitation/rainfall/snowfall
              values or
              'A' indicating that the data have been adjusted according
              the above procedure;
LAT         is the station latitude (°N) with two decimal points;
LON         is the station longitude (°W) with two decimal points;
ELEV        is the station elevation in tenths of meters (Bene!) with a
              missing value of -9999;
YEAR        is the year of the observation minus 1000;

Array P(12) contains 12 monthly totals of precipitation (rainfall, liquid
              water equivalent of snowfall) in tenths of mm (missing values are
              coded "-1");
Array DAT_FLG(12) contains the data flags from the original AES archive. This
              flag can have four values:

```

```

              blank (' ') valid value (no any comments);
              M    missing value;
              T    precipitation trace/traces were reported during
              the month;

```

```

:
:

```

E original value in archive has been estimated.

The files have been sorted by ID (first key), YEAR (second key), and ADJ_FLG (third key). The same record with adjusted values follows essentially each original precipitation (rainfall, liquid water equivalent of snowfall) record. This organization of the data set allows the user to perform easy selection, comparison, and analyses of these climatic variables.

The first several lines of the file CDN_MON.PCP are given below:

```
1010066 O 48.87 123.28 39 984 -1M -1M -1M -1M -1M -1M 34 45 324E 818E 2003E 980E
1010066 A 48.87 123.28 39 984 -1M -1M -1M -1M -1M -1M 34 46 330E 837E 2043E 1002E
1010066 O 48.87 123.28 39 985 230E -1M 731 500 414 414 32 54 325 1318 -1M -1M
1010066 A 48.87 123.28 39 985 235E -1M 746 510 422 422 32 55 332 1344 -1M -1M
1010066 O 48.87 123.28 39 986 1823E 1114 728E -1M 580 207 283 0 335 322 1586 904E
1010066 A 48.87 123.28 39 986 1861E 1192 742E -1M 591 212 289 0 342 328 1617 922E
1010066 O 48.87 123.28 39 987 1114E 514E 770 545E 482E 81 -1M 37 71 163 -1M 1376E
1010066 A 48.87 123.28 39 987 1136E 528E 785 556E 491E 83 -1M 38 73 167 -1M 1403E
1010066 O 48.87 123.28 39 988 751 297E 905 527E 754 207 146E 337 595E 744 1616E -1M
1010066 A 48.87 123.28 39 988 767 306E 924 538E 769 212 148E 344 607E 758 1648E -1M
1010066 O 48.87 123.28 39 989 1016E 728E 913E -1M 487E 312E 210E 405E 37 377 1068 995E
1010066 A 48.87 123.28 39 989 1050E 779E 933E -1M 497E 318E 214E 414E 38 384 1089 1015E
1010066 O 48.87 123.28 39 990 1423E 575E -1M 748E 514E -1M -1M 310 -1M -1M 2273E 1793E
1010066 A 48.87 123.28 39 990 1457E 621E -1M 762E 524E -1M -1M 316 -1M -1M 2319E 1832E
1010235 O 48.40 123.48 170 971 -1M -1M -1M -1M -1M 278E 48 103 495 1071 1658 2171
1010235 A 48.40 123.48 170 971 -1M -1M -1M -1M -1M 298E 58 113 517 1119 1732 2253
1010235 O 48.40 123.48 170 972 2601 2040 1851 550 45 268 569 202 673 360 544 2817E
1010235 A 48.40 123.48 170 972 2706 2117 1923 588 68 288 590 214 698 394 595 2919E
1010235 O 48.40 123.48 170 973 1321 342 320 238 202 257 64 131 156 1113 -1M 1531
1010235 A 48.40 123.48 170 973 1393 386 360 270 228 275 75 141 172 1161 -1M 1597
```

... .. Files CDN_MON.RAI and CDN_MON.SNO have a similar structure.

:
:
: